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Original Article

INVESTIGATION OF MECHANICAL PROPERTIES AND MACHINING BEHAVIOUR OF ALUMINIUM ALLOY FILLED WITH WALNUT CELL MICRO PARTICLES

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ABSTRACT

The use of aluminium alloys in manufacturing industries has increased significantly in recent years. This is primarily because of their ability to combine lightness and strength in a single material. Concomitant to his growth, marching of aluminum alloys has enormously increased in volumetric proportions, so that the chip volume represents up to 80% of the original volume of the machined material in certain segments of the industry, like aerospace. In this context, knowledge of the characteristics of machinability of aluminium alloy is essential to provide industry and researchers with information that allows them to make the right decisions when they come to machining the material. On the other hand, the combination of relevant milling parameters (feed rate, cutting speed, depth of cut) on flat samples (flat specimen have been selected by attempting to reproduce with most accurate ways the geometry and the type of machining process known as face milling is usually used in the manufacturing fields). The results from the whole of the specimens allowed us to evaluate how the main mechanical properties have been affected by the process applied. The purpose of this review is, to compile relevant information about the characteristics of the milling of the aluminium alloy with the walnut particle.

***KEYWORDS*: Aluminium Alloys, Milling, Stir Casting, Electric Discharge Machining, Optical Electron Microscope, Micro Hardness & Surface Roughness**

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INTRODUCTION

The possibilities of traditional materials such as metals and their alloys are so exhausted that even when using the most modern techniques, it may be difficult to achieve the highest material characteristics, and thus higher performance parameters, the durability and reliability of the proposed structures and equipment. For fields such as rocketry and aviation, the automotive and chemical industries, electrical constructions and many other areas, composites are indispensable in a variety of applications today. The advantage of composites as structural materials is to obtain a material of a higher strength, toughness, stiffness, but also a higher resistance to creep, corrosion, wear or fatigue compared to conventional materials. In addition, with a suitable combination of components, we can also obtain a composite of specific properties (thermal, electrical, optical). An alloy is a combination of metals and of a metal or another element. Alloys are defined by a metallic bonding character. An alloy may be a solid solution of metal elements (a single phase) or a mixture phased (two or moresolution). Intermetallic compounds are alloys with a defined stoichiometry and crystal structure. Zintl phases are also sometimes considered alloys, depending on the bond type. Alloys are used in wide variety of applications. In some

cased, a combination of metals may reduce the overall cost of the material while preserving important properties. In other cases, the combination of metals imparts synergistic properties to the constituent metal elements such as corrosion resistance or mechanical strength. The alloy constituents are usually measured by mass percentage for practical applications, and in atomic fraction for basic science studies. Alloys are usually classified as substitution or interstitial alloys, depending on the atomic arrangement that forms the alloy. They can be further classified homogeneous (consisting single phase) or heterogeneous (consisting of two or more phase) or Intermetallic.

METHODOLOGY

Stir Casting

Stir casting is a liquid state method of composite materials fabrication, in which a dispersed phase (ceramic particles, short fibres) is mixed with a molten matrix metal by means of mechanical stirring. Stir casting is the simplest and the most cost effective method of liquid state fabrication. The liquid composite material is then cast by conventional casting methods and may also be processed by conventional metal forming technologies. The components of al alloy and walnut cell are prepared by stir casting method.

Stir casting is characterized by the following features:

Content of dispersed phase is limited (usually not more than 30 vol. %). Distribution of dispersed phase throughout the matrix is not perfectly homogeneous: There are local clouds (clusters) of the dispersed particles (fibres)

There may be gravity segregation of the dispersed phase, due to a difference in the densities of the dispersed and matrix phase.

The technology is relatively simple and low cost. Distribution of dispersed phase may be improved, if the matrix is in semi-solid condition. The method using stirring metal composite materials in semi-solid state is called recasting. High viscosity of the semi-solid matrix material enables better mixing of the dispersed phase.

Micro Hardness

The vickers hardness test was developed in 1921 by Robert Smith and George. Sandland at vickersltd as an alternative to the brinell method to measure the hardness of materials. The vickers test is often easier to use than other hardness tests, since the required calculations are independent of the size of the indenter, and the indenter can be used for all materials irrespective of hardness. The basic principle, as with all common measures of hardness, is to observe a material's ability to resist plastic deformation from a standard source. The vickers test can be used for all metals and has one of the widest scales among hardness tests. The unit of hardness given by the test is known as the vickers pyramid number (hv) or diamond pyramid hardness (dph). The hardness number can be converted in to units of pascals, but should not be confused with pressure, which uses the same units. The hardness number is determined by the load over the surface area of the indentation and not the area normal to the force, and is therefore not pressure. The milled components are tested and reported in this paper.

Surface Roughness

Surface roughness often shortened to roughness, is a component of surface texture. It is quantified by the deviations in the direction of the normal vector of a real surface from its ideal form. If these deviations are large, the surface is rough; if they are small, the surface is smooth. In surface metrology, roughness is typically considered to be the

high-frequency, short-wave length component of a measured surface. However, in practice it is often necessary to know both the amplitude and frequency to ensurethat a surface is fit for a purpose.

Roughness plays an important role in determining how a real object will interact with its environment. In tribology, rough surfaces usually wear more quickly and have higher friction coefficients than smooth surfaces. Roughness is often a good predictor of the performance of a mechanical component, since irregularities on the surface may form nucleation sites for cracks or corrosion. On the other hand, roughness may promote adhesion. Generally speaking, rather than scale specificde scriptors, cross-scale descriptors such as surface fractality provide more meaningful predictions of mechanical interactions at surfaces including contact stiffness and static friction.

The image from an optical microscope can be captured by normal, photosensitive cameras to generate a micrograph. Originally images were captured by photographic film, but modern developments in cmos and charge-coupled device (ccd) cameras allow the capture of digital images. Purely digital microscopes are now available which use a ccd camera to examine a sample, showing the resulting image directly on a computer screen without the need for eyepieces.

Optical Electron Microscope

Optical microscopy is used extensively in microelectronics, nanophysics, biotechnology, pharmaceutics research, mineralogy and microbiology. Optical microscopy is used for medical diagnosis, the field being termed histopathology when dealing with tissues, or in smear tests on free cells or tissue fragments. In industrial use, binocular microscopes are common. Aside from applications needing true depth perception, the use of dual eyepieces reduces eyestrain associated with long workday satamicroscopy station. In certain applications, long-working-distance or long-focus microscopes are beneficial. An item may need to be examined behind a window, or industrial subjects may be a hazard to the objective. Such optics resemble telescopes with close-focus capabilities.

RESULTS AND DISCUSSIONS

Before Milling

Figure 1: Material Before Milling

Table 1: Hardness Value Before Milling

S. No	Aluminium Alloy lm25	Walnut Powder	Hardness
1	100%	0%	113
2	95%	5%	115
3	92.5%	7.5%	111
4	90%	10%	113
5	87.5%	12.5%	110

Hardness Test After Milling

Figure 2: Material After Milling

Table 2: Hardness After Milling

S. No	Aluminium Alloylm25	Walnut Powder	Hardness
1	100%	0%	115
2	95%	5%	116
3	92.5%	7.5%	108
4	90%	10%	114
5	87.5%	12.5%	107

Comparisons of Hardness Value Before and After Milling

Table 3: Comparision of Hardness Value Before and After Milling

S. No	Material	Before Milling	After Milling
1	Aluminium alloyLM25	113	115
2	LM25 with 5% walnut powder	115	116
3	LM25 with 7.5% walnut powder	111	108
4	LM25 with 10% walnut powder	113	114
5	LM25 with 12.5% walnut powder	110	107

Surface Roughness

Figure 3: Surface Work Piece for Surface Roughness

Surface Roughness Value

Table 4: Surface Roughness Value

S. No	Aluminium Alloylm25	Walnut Powder	Surface Roughness
1	100%	0%	1.104
2	95%	5%	1.156
3	92.5%	7.5%	1.083
4	90%	10%	1.114
5	87.5%	12.5%	1.105

MICROSCOPIC VIEW

Aluminum LM25 Before Milling

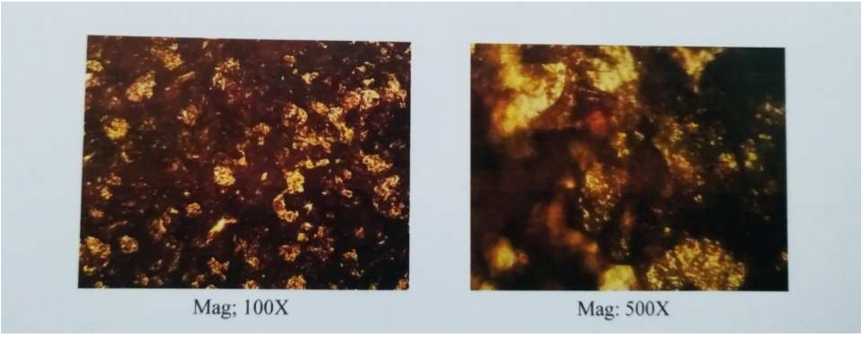

Figure 4: Aluminium LM25 Before Milling

LM25 with 5% Walnut Powder Before Milling

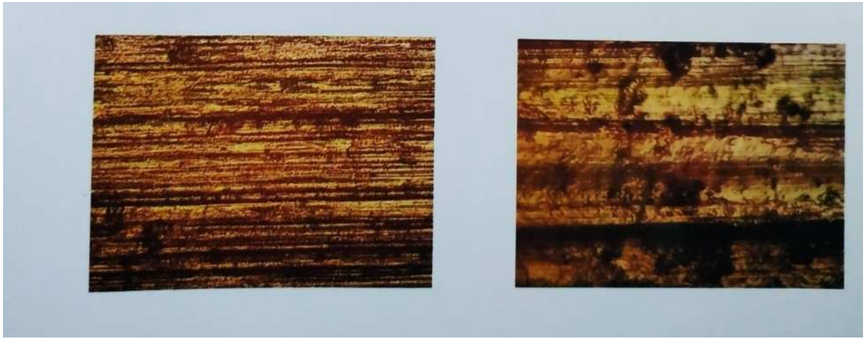

Figure 5: LM25 with 5% Walnut Powder Before Milling

LM25 with 7.5% Walnut Powder Before Milling

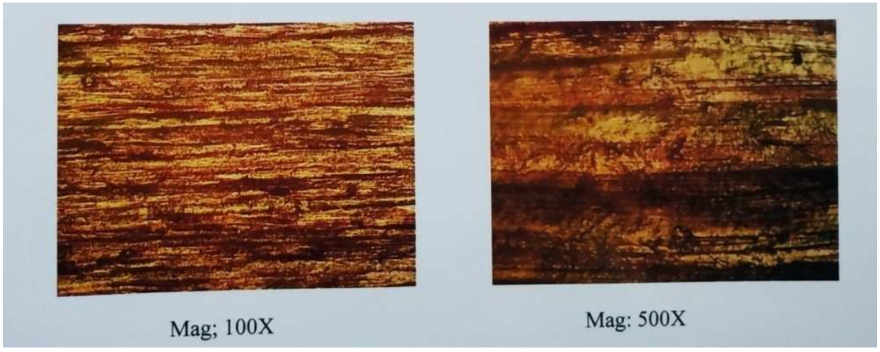

Figure 6: LM25 with 7.5% Walnut Powder Before Milling

LM25 with 10% Walnut Powder Before Milling

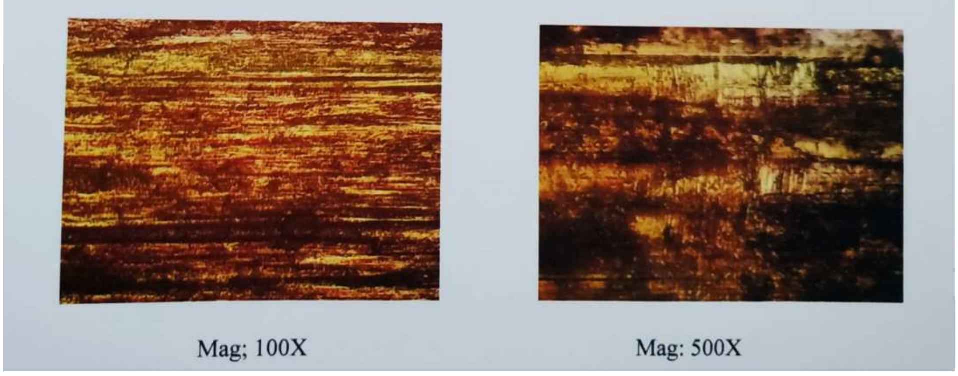

Figure 7: LM25 with 10% Walnut Powder Before Milling

LM25 with 12.5% Walnut Powder Before Milling

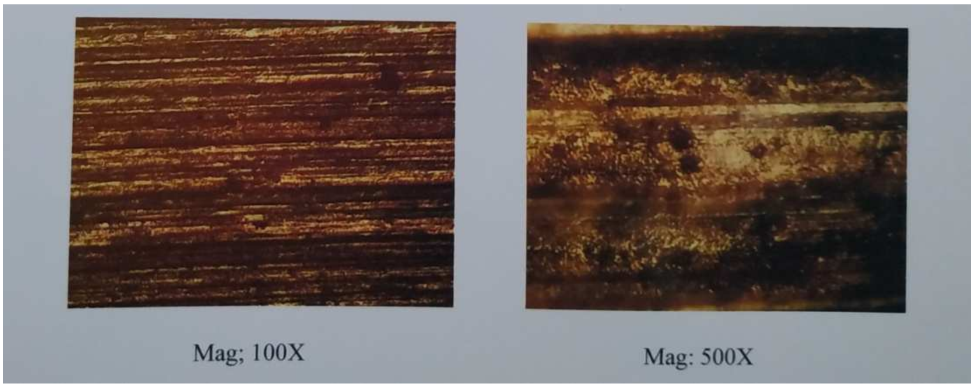

Figure 8: LM25 with 12.5% Walnut Powder Before Milling

Aluminium Alloy LM25 After Milling

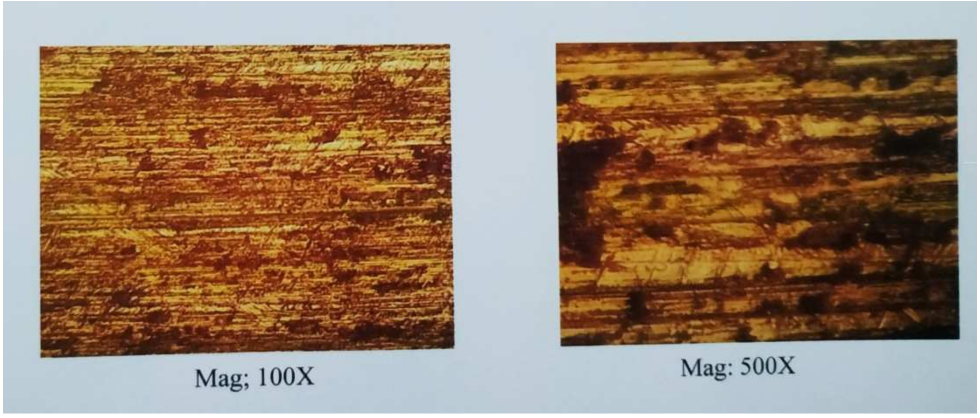

Figure 9: Aluminium Alloy LM25 After Milling

LM25 with 5% Walnut Powder After Milling

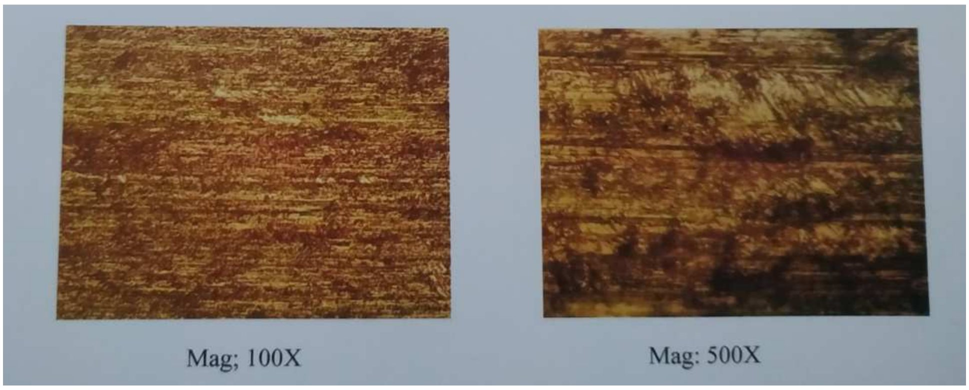

Figure 10: LM25 with 5% Walnut Powder After Milling

LM25 with 7.5% Walnut Powder After Milling

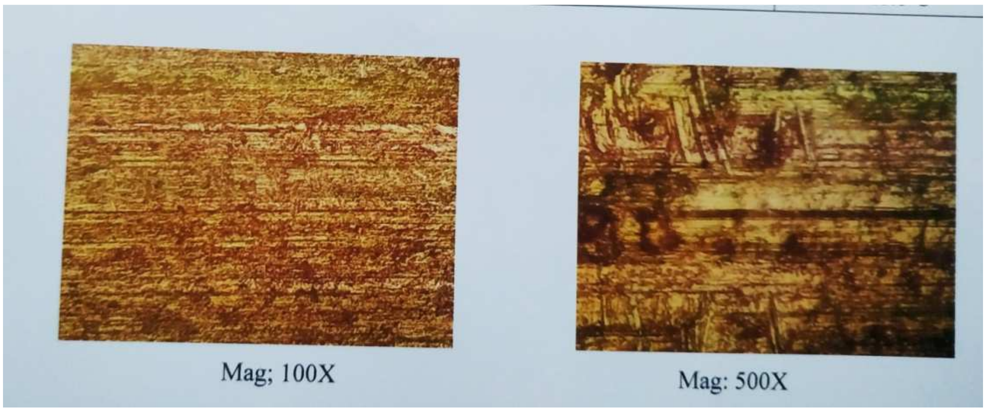

Figure 11: LM25 with 7.5% Walnut Powder After Milling

LM25 with 10% Walnut Powder After Milling

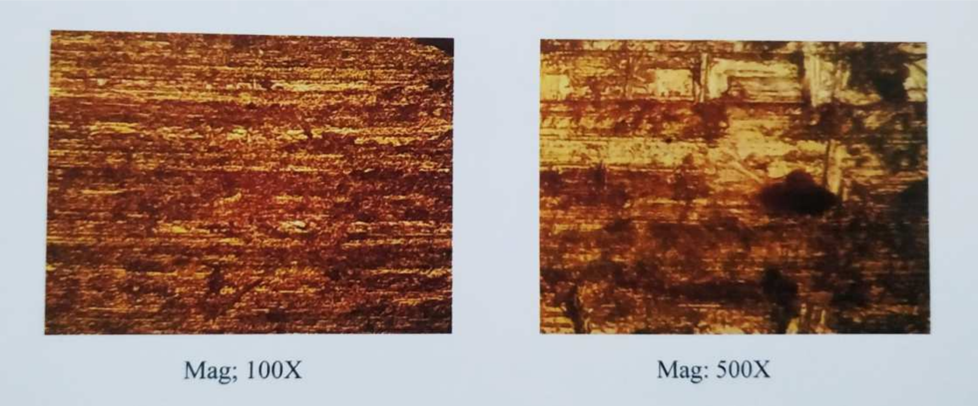

Figure 12: LM25 with 10% Walnut Powder After Milling

LM25 with 12.5% Walnut Powder After Milling

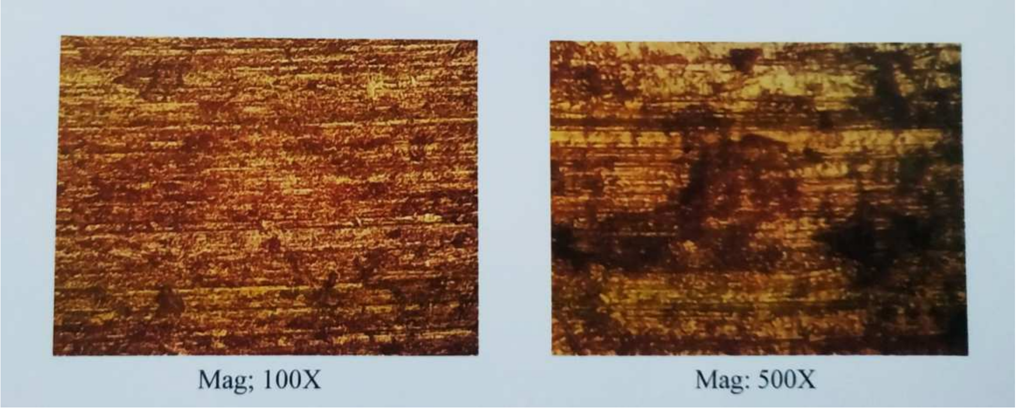

Figure 13: LM25 with 12.5% Walnut Powder After Milling

DISCUSSIONS

The result obtained shows that the hardness of the material increases with the addition of the walnut powder. Until the ten percent of the walnut powder is added to the composition of the aluminium alloy, the hardness increased constantly, after crossing the ten percent, the hardness of the material decreases. The above result is obtained for the aluminium before machining. The hardness of the material changes after machining. The machining process selected is milling.

The hardness of the material increases after milling. Until ten percent of the walnut powder is added to the composite material, the hardness of the material increases constantly and then the hardness decreases. The result obtained shows that the hardness of the material before milling and after milling changes. The hardness of the material increases when milling operation is done.

The surface roughness of the material increases for the addition of the walnut powder in the aluminium alloy. Then, it decreases for the next composition of the walnut. And then, it increases constantly for the next composition and remain constant for further proposition. The result obtained shows that the surface roughness is not constant through out, it varies according to the proposition of the walnut powder.

The microscope view of the material shows the dispersion of the walnut particle to the aluminium composite. The walnut particle is well bonded to the aluminium alloy in the final proposition than the beginning composition. The walnut particle and aluminium alloy are well bonded.

But after the machining operation, the dispersion is spread through out. The machining operation increases the surface roughness, hardness and dispersion of the walnut particles in to the aluminium alloy. The bond between the aluminium alloy and the walnut powder increases with the increase in the proposition of the walnut powder.

CONCLUSIONS

- The result shows that the hardness of the material increases with the addition of the walnut powder. When the ten percent of the walnut powder was added to the composition of the aluminium alloy, the hardness increased constantly. After crossing the ten percent, the hardness of the material decreases. For the same material, the hardness is checked after machining.

- The hardness of the material changes after machining. The machining process selected is milling. Until ten percent of the walnut powder is added to the composite material, the hardness of the material increases constantly and then the hardness decreases. This shows that the hardness of the material before milling and after milling changes. The hardness of the material increases when milling operation is done.
- The surface roughness of the material increases for the addition of the walnut powder in the aluminium alloy. Then, it decreases for the next composition of the walnut. And then, it increases constantly for the next composition and remain constant for the further proposition. The surface roughness is not constant through out.
- The microscope view of the material shows the dispersion of the walnut particle to the aluminium composite. The walnut particle is well bonded to the aluminium alloy in the final proposition than the beginning composition. The walnutparticle and aluminium alloy are well bonded. But after the machining operation, the dispersion is spread through out. The machining operation increases the surface roughness, hardness and dispersion of the walnut particles in to the aluminium alloy. The bond between the aluminium alloy and the walnut powder increases with the increase in the proposition of the walnut powder.

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